Commissioning of the superconducting ECR ion source VENUS

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VENUS (Versatile ECR ion source for NUclear Science) is a next generation superconducting ECR ion source, designed to produce high current, high charge state ions for the 88-Inch Cyclotron at the Lawrence Berkeley National Laboratory. VENUS also serves as the prototype ion source for the RIA (Rare Isotope Accelerator) front end. After 6 years of design and construction the project has recently achieved two major milestones: The first plasma was ignited using 18 GHz microwave in June 2002 and the first mass-analyzed high charge state ion beam was extracted in September of 2002.

Several technical challenges have been solved during the first commissioning months. During the acceptance test in September 2001, the cryostat failed to meet design specifications. The heat exchanger, which couples the LHe Reservoir to the two 1.5 W cryocoolers did not function properly, making it necessary to frequently transfer liquid He. Analysis of the original heat exchanger showed, that the thermal resistance of the flexible copper link was too high to efficiently transfer heat from the He reservoir to the cryocoolers. Therefore, a new design approach was developed [1]. The two cryocoolers can now provide sufficient cooling power for 18 GHz operation.

Another important step was the development of a PLC (programmable logic controller) based external regulation loop for the superconducting magnet power supplies. It allows ramping of the magnets in a reasonable time and stabilizes the magnets at the requested currents without fast oscillations, which can cause quenches.

In addition, a new quartz HV break was developed for reliable 18 GHz microwave operation up to 2 kW. Holes were drilled into the waveguide inside the ion source vacuum chamber for better pumping in this long waveguide section to suppress a parasitic ECR discharge found in initial tests.

So far, the ion source was mainly operated with oxygen and argon gases. The ion source has not yet been tested for very high charge state production, but the ion source performance for the beams tested is promising. Figure 1 shows one of the first argon spectra.

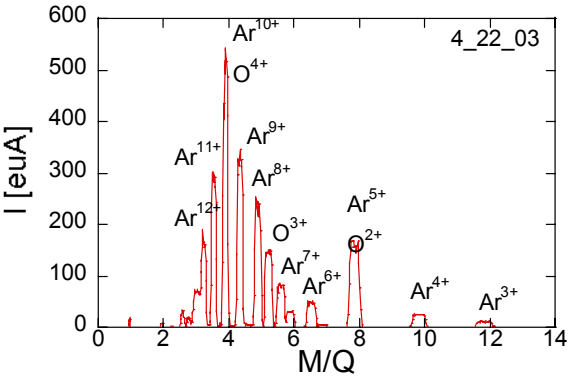

Fig.1 Charge state distribution from VENUS for an argon discharge.

Heavy ion beam and metal ion beam production will be started this summer. Some preliminary results are presented in table 1 and compared with other high performance ECR ion sources.

	AECR-U 10+14 GHz	SERSE 14+18 GHz	VENUS 18 GHz
O^{6+}	570	540	810
O^{7+}	300	225	220
Ar^{11+}	270	260	290
Ar^{12+}	192	200	180

Table 1 First VENUS commissioning results compared to best performance data from the AECR-U [1] and SERSE ion source [2] at the given frequencies.

References

1. M.A. Leitner et.al., Proc. of 15th intern. workshop on ECRIS, University of Jyväskylä, Finland June, 2002

2. S. Gammino et.al., Rev. Sci. Instrum. 70, 3577 (1999)